DRIVVEN

NO_x Sensor Kit User's Manual

USB Module Platform
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Introduction

The Drivven USB NO_x Sensor Module Kits provides an interface for one or two NO_x and O_2 exhaust gas sensors. If you cannot find the answers to your questions within this manual feel free to contact us directly. The more information you can provide us with the better we will be able to assist you.

Features:

- 1-Ch. or 2 Ch. system
- Two signals output:
  - NO_x concentration (ppm)
  - O_2 concentration (%)
- Sensor controller supply voltage of 12V to 16V (24V version available)
- Reverse battery protection on sensor controller module
- Wide range of applications:
  - Gasoline / Diesel
  - Passenger car / Truck
- Helps to achieve emissions requirements
- Includes sensor controller harness
- Stand alone executable that can be run without the need for a LabVIEW license
- USB module-based platform provides
  - Inexpensive alternative to cRIO platform
  - Windows PC-based LabVIEW VIs

System Diagram

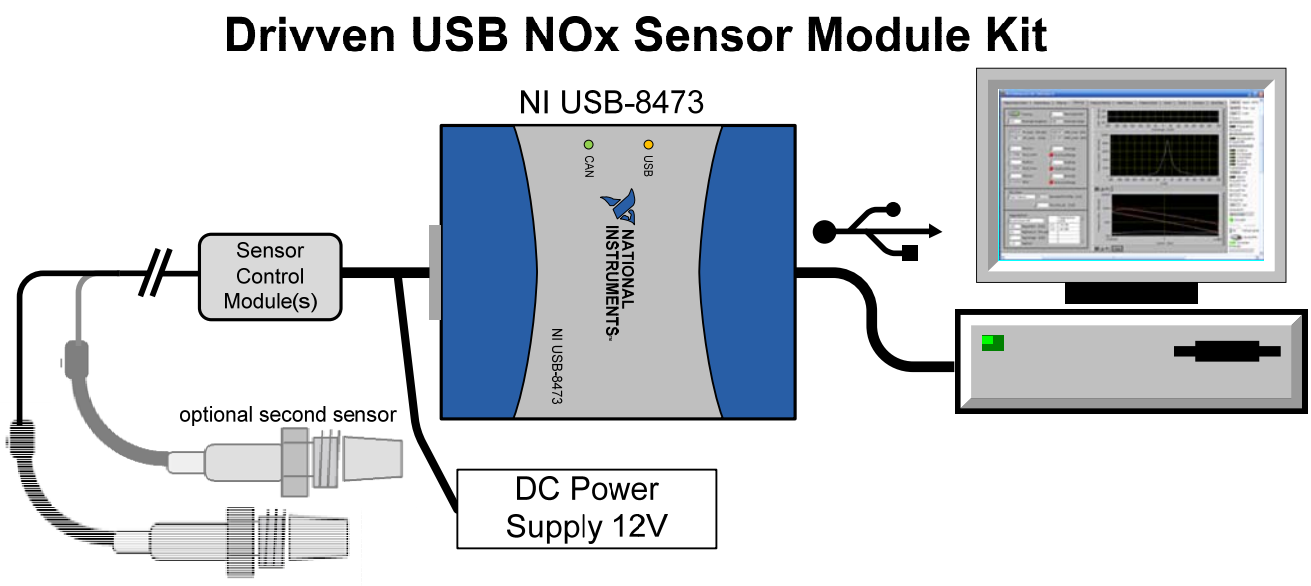

Figure 1 NOx USB System Drawing

Hardware

The USB-based kit provides the following hardware:

1xContinental Uninox Smart NO_x Sensor with integrated sensor controller module (5WK96622A)
1x Sensor bung
1x 5 ft Wiring harness for NO_x sensor controller module connection to USB-8473 and power supply
1x National Instruments USB-8473 USB high speed CAN module

The Drivven NOx USB software toolkit is only compatible with the Continental Uninox Smart NOx Sensor having a part number of 5WK96622A. There are many additional Continental NOx sensor modules that can be found in various OEM engine applications. All of these Sensor Control Modules communicate over CAN. They likely have a different part number and different proprietary calibration. Each OEM sensor is programmed with proprietary communication protocols. Drivven cannot support those sensors. The NOx sensor modules provided by Drivven are engineering samples procured directly from Continental. If you already have the correct sensor module, then you may purchase the NOx sensor module kit without the included sensor module. Please contact Drivven for a quote.

The wiring harness that is included with the USB NOx kit is a five foot cable that connects to the NOx Sensor Control Module and then splits into two cables for the USB-8473 module and an external power supply. The first cable connects to the USB-8473 with a female DB-9 connector. A terminating resistor of approximately 120 ohms is hidden inside this cable near the NOx Sensor Control Module, between the CAN High and CAN Low wires. The second cable provides three un-terminated leads for connecting to a power supply (2 leads) and for address selection of the NOx sensor module (1 lead). If the cable is to be extended, CAN network wiring guidelines must be followed. Please refer to the operating instructions provided with the NI USB-8473 CAN module for more details.

Powering the Hardware

The NO_x Sensor Controller Module requires power from a range of 12V to 16V with a continuous current of 0.6A and a peak current of 12A. The maximum power requirement is 20W which typically occurs when the heating element is being turned on from a cold state. If you are using two sensors make sure to double the capacity of your power supply.

Continental Smart NO_x Sensor Module Specifications

Table 2. NO_x Sensor Performance Specifications

Output Type	Measurement Range	Accuracy	Response Time (33-66%)	Data Update Rate
NO_x	0 – 3000 ppm	@ 0 ppm: ±10 ppm @ 100 – 1500 ppm: ±10% @ 1500 – 3000 ppm: undefined	1300 ms (fresh) 1650 ms (aged)	50 ms interval @ 250 kBaud
O_2	-12 – 21 [%]	@ λ=0.90: ±1.4% (fresh) @ 0% (λ=1.00): ±0.13% (fresh) @ 0% (λ=1.00): ±0.25% (aged) @13% (λ=2.65): ±0.32% (fresh)	1000 ms (fresh) 1300 ms (aged)	

NO_x Sensor Light-off times (Conditions: Air T = 25 ±5°C, BattV = 28V, Heater turned ON)

NO_x	< 100 sec
O_2	< 80 sec

NO_x Sensor Preheating Function

If the power supply is on, the sensor is in preheating mode until the Sensor#Enable Boolean is set to TRUE. If the Sensor#Enable Boolean is set to FALSE, the sensor returns to preheating mode. The preheating mode protects the sensor from mechanical cracks caused by water splash.

NO_x Sensor Operating Temperature Ranges

Minimum sensor module controller temperature	-40°C
Maximum sensor module controller temperature	105°C

Sensor module controller temperature range of 85°C to 100°C allowed for up to 10 minutes

Minimum storage temperature	-40°C
Maximum storage temperature	120°C
Maximum storage time	2 years
Maximum exhaust gas temperature	800°C

Exhaust gas temperature of 950°C allowed up to 100 hours

Maximum sensor hexagon screw temperature	620°C

Sensor hexagon screw temperature of 650°C allowed for up to 100 hours

Maximum sensor grommet temperature	200°C

Sensor grommet temperature of 230°C allowed for up to 100 hours

Minimum preheating sensor temperature	80°C
Maximum preheating sensor temperature	120°C
Lifespan approved by life cycle pattern	2000 hours or 120K miles

NO_x Sensor Electrical Characteristics

NO_x Sensor Supply Voltage

Minimum supply voltage	12 V
Maximum supply voltage	16 V

If supply voltage > 32 V, sensor is not operated

NO_x Sensor Supply Current	
Average supply current	0.6 A
Peak supply current at switch on	12 A
Inrush current	20 A
Supply Power	
Maximum supply power	20 W
NO_x Sensor Misc.	
Thread Torque	50 Nm
Lubrication	Anti-Seize Compound

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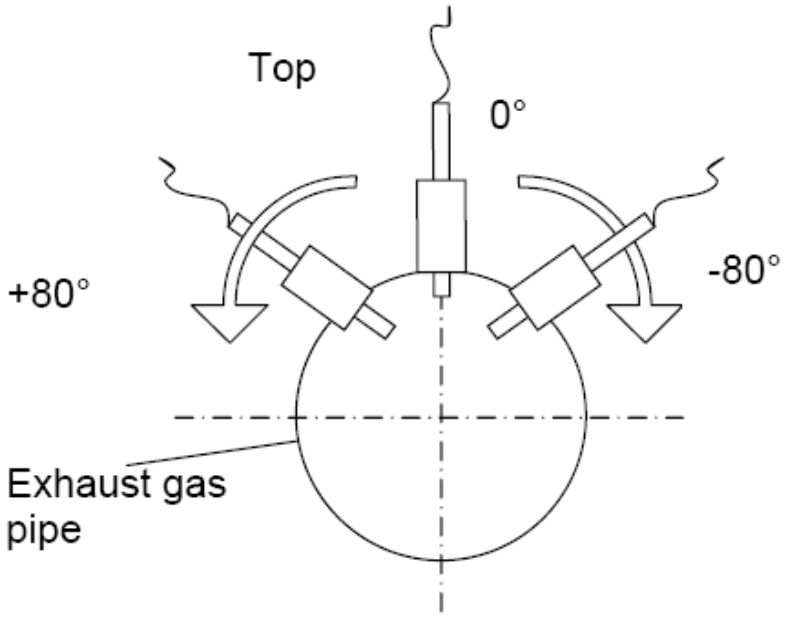


Figure 2 Installation Position

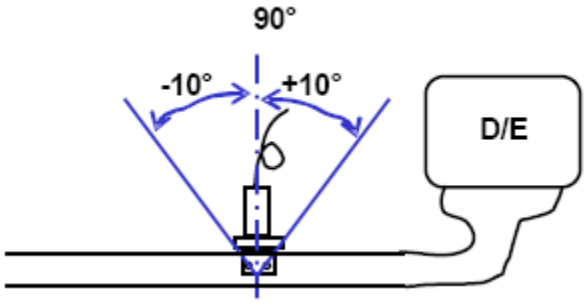


Figure 3 Tilt Angle in Gas Flow Direction

NO_x Sensor Controller Module Connector

Type of connector	Hirschmann MLK 872-860-501
Number of pins	5
Connector pin assignment	Pin 1: Battery [red] Pin 2: Ground [black] Pin 3: CAN Low [blue] Pin 4: CAN High [orange] Pin 5: Address Switch [purple]

Pulling pin 5 to ground changes the CAN transmit ID of the Sensor Control Module so that two NOx Sensor Control Modules can be added to the same network. Sensor Control Modules (SCM) with pin 5 floating are channel 1 and SCMs with pin 5 grounded are channel 2.

USB Platform Compatibility

The NI USB-8473 will work on any windows based PC meeting the minimum requirements below.

- Hardware
  - Windows 7/Vista/XP/2000
  - Minimum of 1 GB of RAM
  - Pentium 4/M or equivalent processor
  - USB port that supports 250 mA at 5 VDC

Software and Activation

The NO_x Sensor USB Module Kit is provided with an installer package which may be downloaded from Drivven's Sharepoint website after obtaining login access from Drivven. User's may go to http://portal.drivven.com/SoftwareDownload and enter the provided username and password to gain access to the specific product installer packages which have been purchased. This package can be installed for two different purposes. First, if the end user is familiar with LabVIEW and has a LabVIEW development license then the installer package should be run on the intended development computer to work with the installed open-source example project. Second, if the end user does not have a LabVIEW development license then they can run the installed stand-alone executable for displaying, recording and saving NOx ppm and O2% measurements.

Regardless of the final intended use, after installing the package, a "Start->Programs->Drivven->ProductRelease" menu item will be added to the start menu. The specific product will have an example LabVIEW project appear under the "Examples" menu and the user manual will appear under the "Manuals" menu. User's may copy and open the example project to experiment with the USB module or use it as a starting point for a new application. All LabVIEW software files, example projects, stand-alone executable and documentation are installed to: C:\Program Files\National Instruments\LabVIEW X.X\vi.lib\addons\DrivvenProductRelease\.

When working with block diagrams, user's will notice a "Drivven" function palette added to the standard LabVIEW palette containing all of the included VIs shown below. VIs for a specific Drivven product will be categorized according to product name. Also, some Drivven products will install RT and FPGA VIs under a "General" function palette which is intended to be used across multiple products.

Activation

After installing the NOx USB kit, it must be activated in order to enable its components. The serial number of the CAN device being used with the toolkit is used to generate an activation code. The serial number of the CAN device (typically a 7 digit hex number located on the bottom of the USB-8473) must be e-mailed to license@drivven.com along with your name, company name, address and telephone number. Please allow 1-3 business days to validate your account and generate a key. An activation key or keys (32 Characters ex. 9DCJ-RN79-QBEE-TPKW-BBAB-GT3Z-RXYC-CFCW) will be generated by Drivven and sent to the customer via reply email. The key(s) will contain only the following characters A B C D E F G H J K L M N P Q R S T W X Y Z 3 4 7 9. The activation key(s) may expire at a specific time if configured to do so.

In order for the stand-alone executable and LabVIEW VIs to run, a text file called USB_NOx.dat must be placed in "c:\ni-rt\system". Within the USB_NOx.dat file, the activation keys for the CAN devices that you are intending to use with the NOx USB kit need to be listed. An example of what the final placement of this file should look like is shown below in Figure 4. When using the VI toolkit, the NOx_CAN_Initialize_revA.vi needs to be the first VI from the toolkit to be called. It will validate the NOx USB license and unlock the remaining NOx USB VIs.

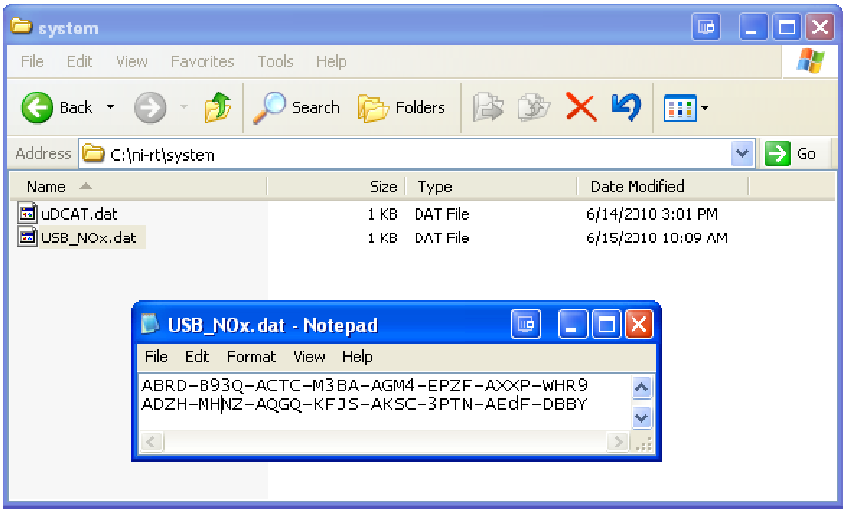


Figure 4 USB_NOx.dat Placed within the Correct Directory with a list of Activation Codes

Requirements

The Drivven USB based VIs require:

- LabVIEW 8.6 (or higher) Base Development System
- NI-CAN 2.6.3

Using the standalone executable requires:

- LabVIEW Runtime Engine 2009
- NI-CAN 2.6.3

The Runtime Engine may be downloaded from the following address http://joule.ni.com/nidu/cds/view/p/id/1383/lang/en or search www.ni.com for "LabVIEW Runtime Engine 2009". The LabVIEW Runtime installer is ~160 Mb. NI-CAN 2.6.3 may be downloaded from the NI website or found on the installation disk that comes with the NI USB-8473.

The NO_x USB Sensor Module Kit is provided with all of the necessary VIs to communicate with the NOx Sensor Control Module over CAN. An example LabVIEW project is provided to show the end user a recommended setup using the provided VIs. The end-user is free to modify the top level VI using LabVIEW 8.6 (or higher) in order to integrate the example with existing DAQ code or modify to add additional functionality.

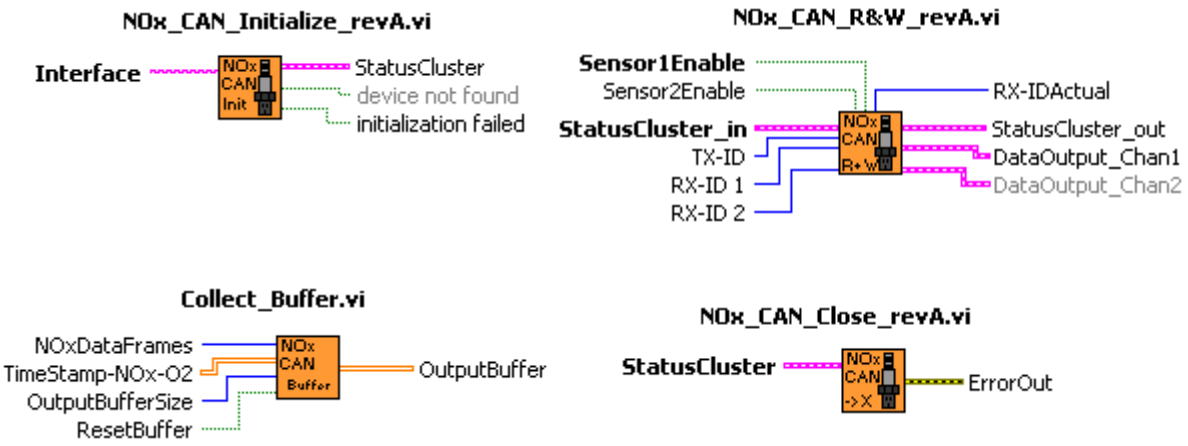


Figure 5. NOx_CAN_Intialize.vi, NOx_CAN_R&W.vi, NOx_CAN_Close.vi and Collect_Buffer.vi icons with leads.

USB Stand Alone Executable Documentation

The stand-alone executable included with the NOx USB kit is based on the NOx_USB_example.vi that is included with the LabVIEW example project. For convenience, the stand alone executable has additional features for troubleshooting and saving data easily. This section will explain some of the controls/indicators and functionality of the stand alone executable.

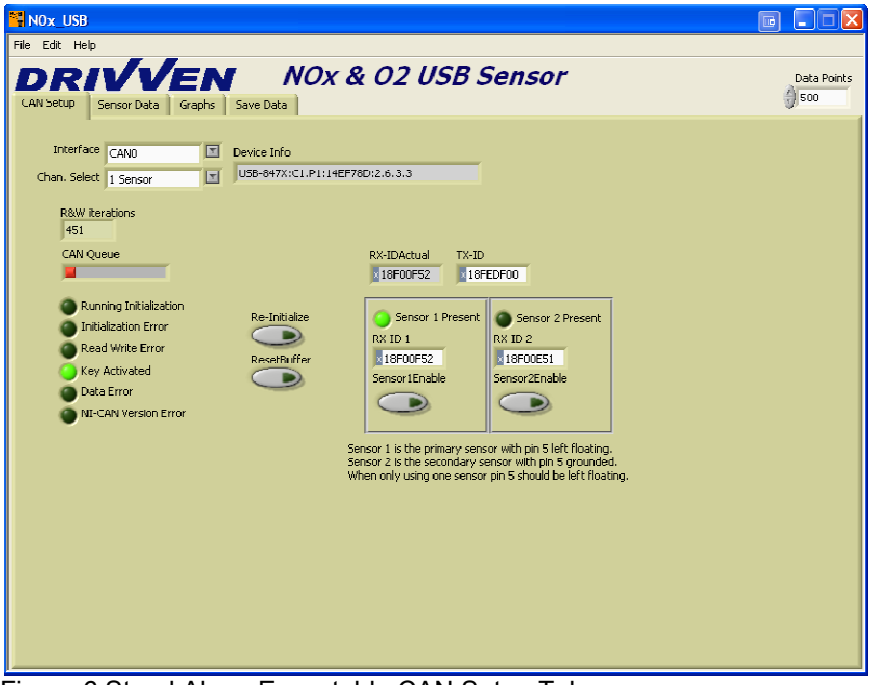


Figure 6 Stand Alone Executable CAN Setup Tab

The USB NOx stand alone executable is broken down into 4 different tabs which are shown in Figure 6, 7, 8 and 9. The CAN setup tab contains all of the controls and indicators needed to get the system up and running. In order to get the program running correctly the only CAN setting that needs to be set is the interface. Setting up the correct interface is important and should be double checked by running Measurement and Automation Explorer. More directions on setting this up can be found below in the list of things to get the system running the first time. The RX-ID1, RX-ID2 and TX-ID should not be changed from their default values unless you completely understand the meaning and impact of the change. CAN queue is an indicator showing the number of CAN data frames coming in off the CAN bus from NOx Sensor Control Modules. If the queue reaches 100% of the progress bar than CAN data frames are coming in faster than data can be calculated. This should not occur unless something is wrong.

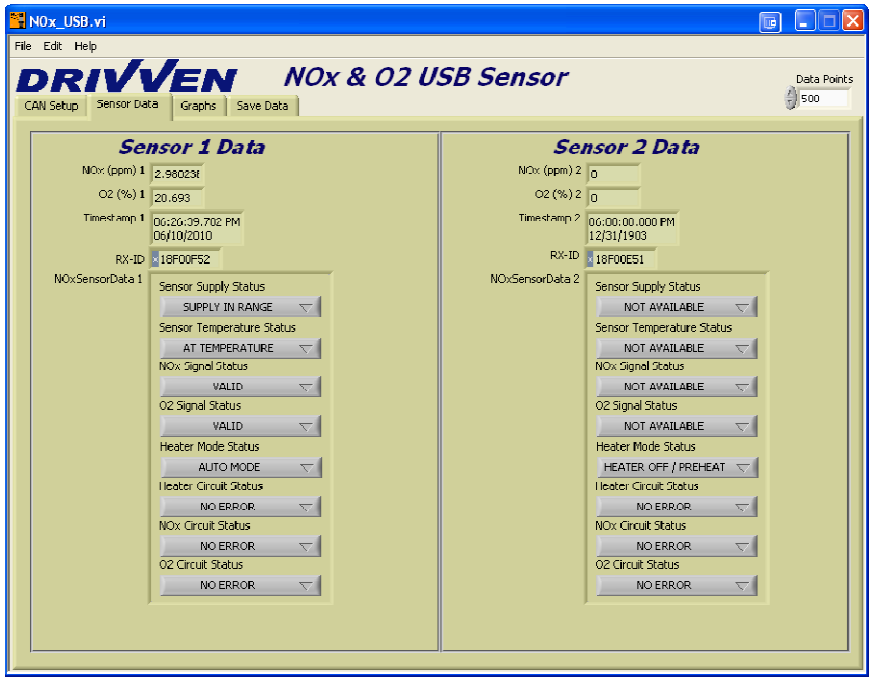


Figure 7 Stand Alone Executable Sensor Data Tab

The sensor data tab displays a text based display of all information regarding sensor 1 and sensor 2. A graphical display of the NOx and O2 collected can be seen in the graphs tab. The number of data points displayed is set with the Data Points control.

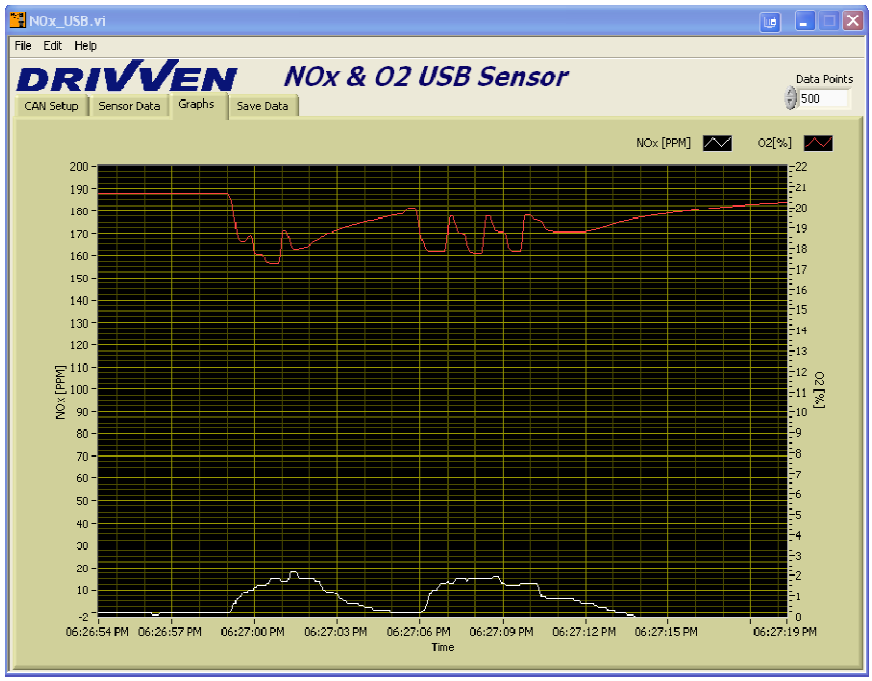


Figure 8 Stand Alone Executable Graph Tab

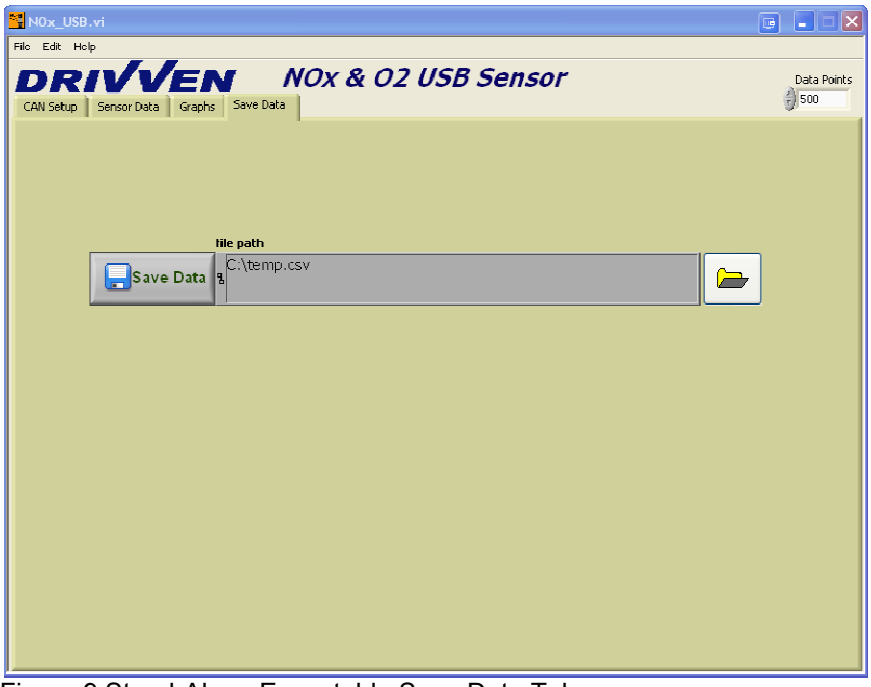
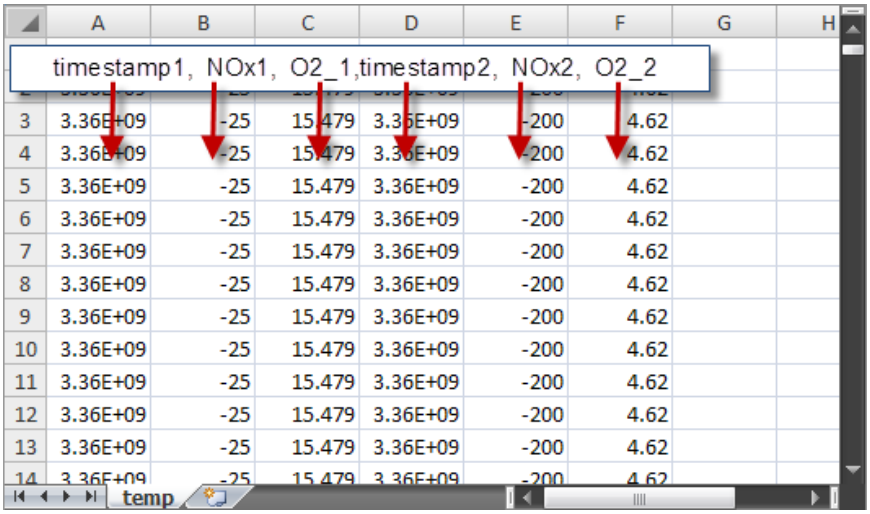


Figure 9 Stand-Alone Executable Save Data Tab

The Save Data tab contains the controls so that the current data displayed on the graphs can be saved to a text file in a designated location. When entering the file path don't forget to add a file extension. In the saved data file the first column of data is a LabVIEW time stamp followed by a column of NOx data and then O2 data. If there are two sensors then the output file has 6 columns of data as shown below in Figure 10.



	A	B	C	D	E	F	G	H
3	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
4	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
5	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
6	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
7	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
8	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
9	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
10	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
11	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
12	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
13	3.36E+09	-25	15.479	3.36E+09	-200	4.62		
14	3.36E+09	-25	15.479	3.36E+09	-200	4.62		

Figure 10 Saved Data Output from NOx_USB stand alone application

Because this stand alone application was based on the provided example, many of the control and indicator descriptions for the example VI are applicable to the stand alone application. Tip strips and descriptions of controls and indicators can also be seen by right clicking on an object and then selecting Description and Tip.

To run the application for the first time:

1. Install LabVIEW Runtime Engine 2009, NI-CAN 2.6.3 and the Drivven NOx package installer.
2. Plug the NI USB-8473 into an available USB port.
3. Go to the start menu->All Programs->Drivven->NOx USB and run NOx_USB.exe.
4. Run Measurement & Automation Explorer (installed with the LabVIEW runtime engine and with NI-CAN 2.6). Under "My System" expand the "Devices and Interfaces" section. If your NI USB-8473 is plugged into an available USB port on your computer then it should be visible. Expanding the USB-8473 tree will show the properties of your device as shown in Figure 6. Right clicking on the port (highlighted in Figure 6) allows you to open up the port properties and change the interface name. Typically if you only have one CAN device with one port the interface name is "CAN0".
5. On the NOx_USB.exe CAN setup tab, select the correct interface name (as defined by Measurement & Automation Explorer) for the device that is connected to the NOx Sensor Control Module.
6. In NOx_USB.exe go to the Help menu and select "Send Activation Request Email" and fill out the email and send it. Or if you use a web based email service send an email to license@drivven.com with your name, company, phone number and serial number.
7. After receiving your activation code from Drivven follow the activation directions in the Software and Activation section to complete your activation.
8. Verify that the wiring harness is plugged into the NI USB-8473, NOx Sensor Control Module and power supply. Please refer to the attached wire labels and NOx Sensor Control Module hardware specifications for pin names.

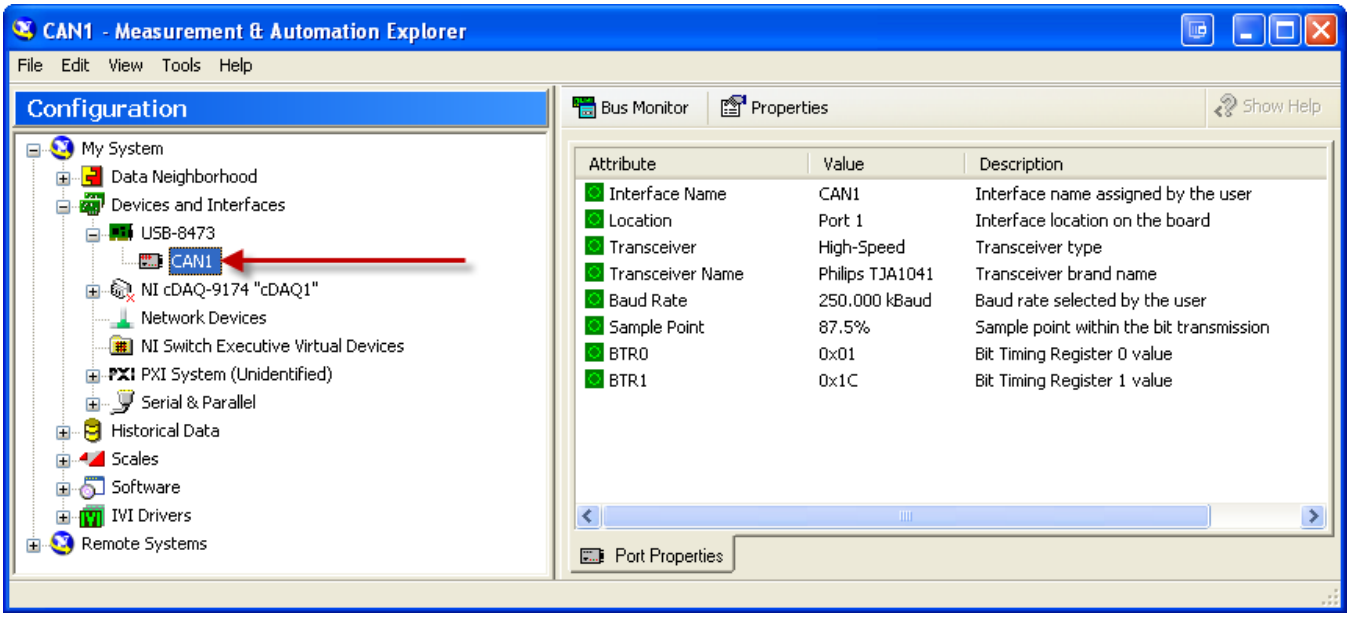


Figure 11 Measurement & Automation Explorer Window

9. Turn the NOx Sensor Control Module on. NOTE: When the sensor is on, the plastic cover should always be removed! The sensor gets very hot so if you are bench testing plan ahead as to where you place the sensor.
10. Make sure that the Sensor1Enable(on the CAN setup tab) button is depressed. (this is the default position)
11. Enjoy your NOx and O2 data!

After following these directions the sensor should go through a warm-up procedure before showing valid data for NOx [PPM] and O2 [%] on the Sensor Data and Graphs tab.

Exploring the USB Example Project

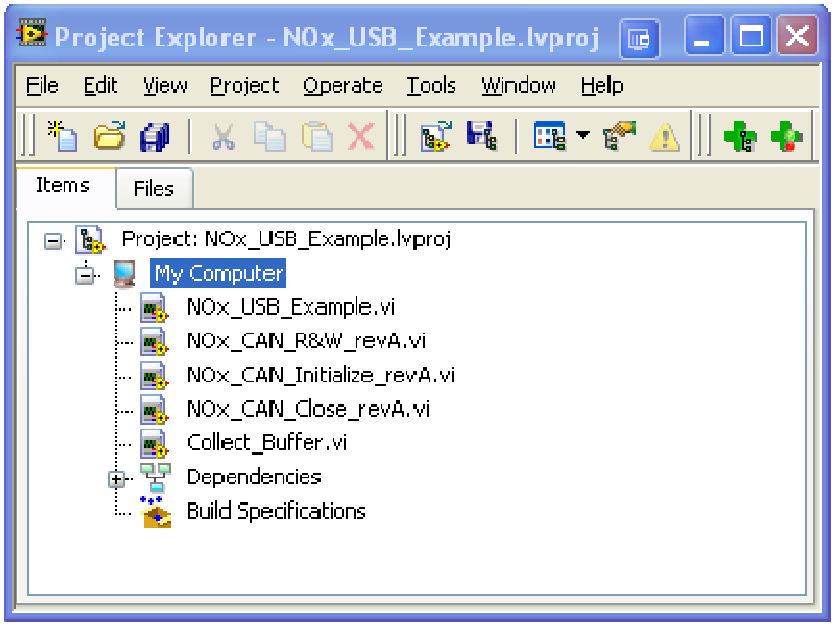


Figure 12 Project Explorer Window

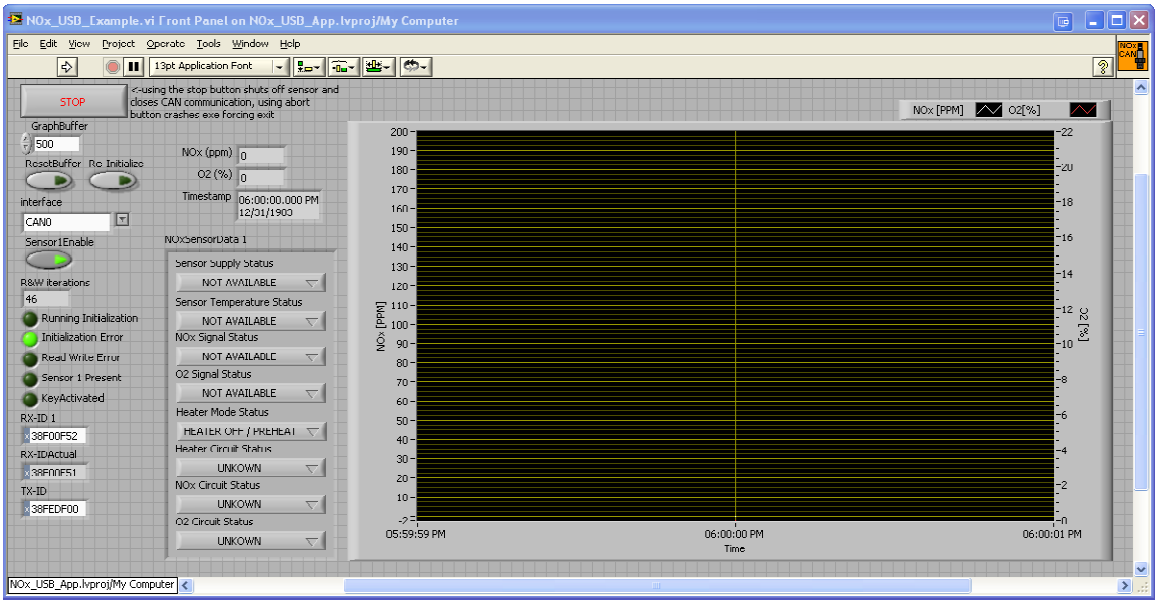


Figure 13 NOx_USB_Example.vi Front Panel

All of the VIs included with the NOx Sensor Module Kit along with an example application with the VIs setup can be found within the project NOx_USB_Example.lvproj. The project provides a way of verifying that all of the dependent libraries are properly installed on the computer being used. The example application is setup to give the end user a starting point for developing their own application that meets their needs. This example is documented in more detail within the block diagram. Each of the inputs and outputs of the VIs included in the NOx Sensor Module kit are described in more detail below.

Example Application Indicators and Controls Description:

- **Data Buffer:** The number of elements to be collected in a streaming buffer. This buffer is displayed on the graph and saved to a file when the SaveData button is used. Whenever this value is changed the buffer needs to be reset before the change will be applied.
- **ResetBuffer:** Reset the streaming buffer to clear erroneous data from the graph and redefine the size of the buffer.
- **Re-Initialize:** Forces the program to run through the CAN bus initialization process and clears errors if possible.
- **Interface:** The interface name of the port being used to connect to the NOx Sensor Control Module. This is defined/changed in Measurement & Automation Explorer.
- **Sensor1Enable:** Transmits a CAN message to the channel 1 NOx Sensor Control Module to turn the sensor on. Sensor 1 is defined as a control module that has pin 5 floating.
- **R&W iterations:** Loop count of the timed loop that contains the read and write VI.
- **Running Initialization:** Indicates that the initialization of the CAN bus is running.
- **Initialization Error:** Indicates that the initialization process timed out or ran into an error it couldn't clear.
- **Read Write Error:** Indicates that during the read/write process an error was encountered.
- **Sensor 1 Present:** Indicates that messages are being received from a channel 1 NOx Sensor Control Module.
- **RX-ID 1:** The CAN frame ID received from a channel 1 NOx Sensor Control Module. Should not be changed.
- **RX-ID Actual:** Any CAN frame ID that is being read on the CAN bus.
- **TX-ID:** The ID of the CAN frame that is transmitted to control the NOx Sensor Control Modules. Should not be changed.
- **NOx (PPM) :** Current NOx PPM reading from sensor 1.
- **O2 (%) :** Current O2 % reading from sensor 1.
- **TimeStamp :** Time that the most current values were received for channel 1.
- **NOxSensorData 1:** Display information describing the current state of the sensor for channel 1.
- **Sensor Graph:** Graph displaying the buffer when in 1-sensor mode.

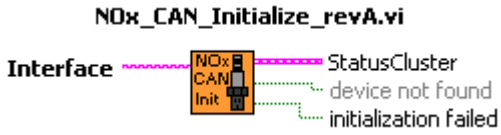
USB Sub VI Documentation

NOx_CAN_Initialize_revA.vi
The NOx_CAN_Initialize VI should be placed outside of the while loop which calls NOx_CAN_R&W_revA.vi (as shown in the example).

Within this VI the toolkit is activated so this VI must be the first NOx USB toolkit VI to run in a program. For ideas on how to layout the structure of a custom application using these VIs please refer to the example application. The NI USB-8473 CAN Module properties are automatically set within this VI to the following values:

Start On Open = TRUE
Baud Rate = 250 Kbps
Read Queue Length = 25 frames
Write Queue Length = 25 frames
Standard Comparator = 0
Standard Mask = 0
Extended Comparator = 0
Extended Mask = 0

Other CAN nodes may be connected to the same CAN bus, as long as they conform to the above properties.



Interface A string input that describes the name of the CAN device that is being used to connect to the Sensor Control Module. The name of the CAN device is the same as what is specified in NI Measurement & Automation Explorer.

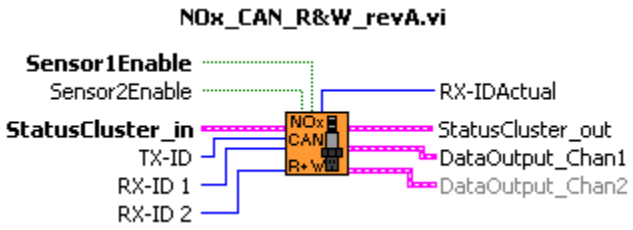
StatusCluster A cluster that passes information between the Initialization process and the read & write process.

- **ObjHandle Out** The object handle for all subsequent NI-CAN VIs for the communication object that is opened during the initialization process.
- **Error Out** Passes the status, code and source of an error throughout the program so that it can be displayed at closing.

device not found This Boolean indicator is true when no CAN device, either USB, serial, PCI or PXI could be found during the initialization process. This is output for troubleshooting purposes.

initialization failed Boolean indicator that is TRUE when the initialization process fails after 100 attempts. This output will not be true unless there is an interruption in the USB or CAN communications for an extended period of time.

NOx_CAN_R&W_revA.vi
The NOx CAN read and write VI should be placed in its own while loop (as shown in the example). Sensor Control Modules (SCM) with pin 5 floating are channel 1 and SCMs with pin 5 grounded are channel 2.



Sensor1Enable A control that either enables or disables the channel 1 internal heater and communication. These heaters should not be turned on unless the user is positive that the sensor is not exposed to water droplets from condensation.

Sensor2Enable A control that either enables or disables a broadcast of a CAN message that turns channel 2's sensor's internal heaters on. These heaters should not be turned on unless the user is positive that the sensor is not exposed to water droplets from condensation.

StatusCluster_in A cluster that passes information between the Initialization process and the read & write process.

- **ObjHandle In** The object handle for all subsequent NI-CAN VIs for the communication object that is opened during the initialization process.
- **Error In** Passes the status, code and source of an error throughout the program so that it can be displayed at closing.

TX-ID ID of the CAN message that is broadcast to the Sensor Control Module.

RX-ID 1 ID of the CAN message that should be received from the Sensor Control Module for channel 1.

RX-ID 2 ID of the CAN message that should be received from the Sensor Control Module for channel 2.

Rx-IDActual ID of the CAN messages received from the CAN bus.

StatusCluster_out A cluster that passes information between the read & write process and the close process.

- **ObjHandle Out** The object handle for all subsequent NI-CAN VIs for the communication object that is opened during the initialization process.
- **Error Out** Passes the status, code and source of an error on through the program so that it can be displayed at closing.
- **TX-ID** ID of the CAN message that is broadcast to the Sensor Control Module. This value is passed within this cluster so that the close VI can shut down the Sensor Control Module so that the sensor isn't accidentally left on.

DataOutput_Chan1 Calibrated data output and sensor status relating to channel 1.

NOxDataFrames 1 Number of frames for channel 1 recorded and converted since the last time the USB CAN modules cue was emptied. This number also indicates the number of values that were overwritten in the TimeStamp-NOx-O2 array that are then collected by the Collect_Buffer VI.

NOxSensorData 1 A cluster of sensor status ring indicators for channel 1

Sensor Supply Status Provides status information about the NOx sensor power supply.

The following status messages are provided:
NOT IN RANGE
SUPPLY IN RANGE
ERROR
NOT AVAILABLE

Sensor Temperature Status Provides status information about the NOx sensor heater temperature.

The following status messages are provided:
NOT AT TEMPERATURE
AT TEMPERATURE
ERROR
NOT AVAILABLE

NOx Signal Status Provides status information about the NOx sensor NOx ppm measurement.

The following status messages are provided:
NOT VALID
VALID
ERROR
NOT AVAILABLE

O2 Signal Status Provides status information about the NOx sensor O2 measurement.

The following status messages are provided:
NOT VALID
VALID
ERROR
NOT AVAILABLE

Heater Mode Status Provides status information about the NOx sensor heater control mode.

The following status messages are provided:
AUTO MODE
HEATUP SLOPE 3 OR 4
HEATUP SLOPE 1 OR 2
HEATER OFF / PREHEAT

Heater Circuit Status Provides status information about the NOx sensor heater circuit.

The following status messages are provided:

OPEN WIRE
SHORT CIRCUIT
NO ERROR.

NOx Circuit Status Provides status information about the NOx sensor NOx measurement circuit.

The following status messages are provided:
OPEN WIRE
SHORT CIRCUIT
NO ERROR.

O2 Circuit Status Provides status information about the NOx sensor O2 measurement circuit.

The following status messages are provided:
OPEN WIRE
SHORT CIRCUIT
NO ERROR.

TimeStamp-NOx-O2 1 A two dimensional array having 3 columns of data in the following order: TimeStamp (seconds since January 1, 1904), NOx (ppm), and O2 (%). The array has a fixed number of 20 rows. Each call to NOx_CAN_R&W_revA.vi takes all buffered CAN messages from the CAN device since the last call and filters out every message except for the NOx sensor module messages identified by the specified RxID. These new messages overwrite the TimeStamp-NOx-O2 array from the top. NOxDataFrames identifies the number of new data points received into the array.

NOx Module Present 1 Indicates whether the channel 1 NOx sensor is powered, properly connected, and detected on the CAN bus.

DataOutput_Chan2 Calibrated data output and sensor status relating to channel 2.

NOxDataFrames 2 Number of frames for channel 2 recorded and converted since the last time the USB CAN modules cue was emptied. This number also indicates the number of values that were overwritten in the TimeStamp-NOx-O2 array that are then collected by the Collect_Buffer VI.

NOxSensorData 2 A cluster of sensor status ring indicators for channel 2

Sensor Supply Status Provides status information about the NOx sensor power supply.

The following status messages are provided:
NOT IN RANGE
SUPPLY IN RANGE
ERROR
NOT AVAILABLE

Sensor Temperature Status Provides status information about the NOx sensor heater temperature.

The following status messages are provided:
NOT AT TEMPERATURE

AT TEMPERATURE
ERROR
NOT AVAILABLE

NOx Signal Status Provides status information about the NOx sensor NOx ppm measurement.

The following status messages are provided:
NOT VALID
VALID
ERROR
NOT AVAILABLE

O2 Signal Status Provides status information about the NOx sensor O2 measurement.

The following status messages are provided:
NOT VALID
VALID
ERROR
NOT AVAILABLE

Heater Mode Status Provides status information about the NOx sensor heater control mode.

The following status messages are provided:
AUTO MODE
HEATUP SLOPE 3 OR 4
HEATUP SLOPE 1 OR 2
HEATER OFF / PREHEAT

Heater Circuit Status Provides status information about the NOx sensor heater circuit.

The following status messages are provided:
OPEN WIRE
SHORT CIRCUIT
NO ERROR.

NOx Circuit Status Provides status information about the NOx sensor NOx measurement circuit.

The following status messages are provided:
OPEN WIRE
SHORT CIRCUIT
NO ERROR.

O2 Circuit Status Provides status information about the NOx sensor O2 measurement circuit.

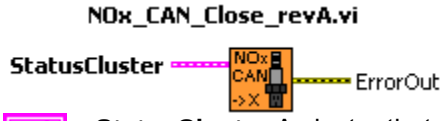
The following status messages are provided:
OPEN WIRE
SHORT CIRCUIT
NO ERROR.

TimeStamp-NOx-O2 2 A two dimensional array having 3 columns of data in the

following order: TimeStamp (seconds since January 1, 1904), NOx (ppm), and O2 (%). The array has a fixed number of 20 rows. Each call to NOx_CAN_R&W_revA.vi takes all buffered CAN messages from the CAN device since the last call and filters out every message except for the NOx sensor module messages identified by the specified RxID. These new messages overwrite the TimeStamp-NOx-O2 array from the top. NOxDataFrames identifies the number of new data points received into the array.

NOx Module Present 2 Indicates whether the channel 2 NOx sensor is powered, properly connected, and detected on the CAN bus.

NOx_CAN_Close_revA.vi
This VI should be placed outside of all while loops so that it is the last thing that runs during a shut down procedure(as shown in the example). This VI closes the CAN read and write process and turns off any connected sensors.



StatusCluster A cluster that passes information between the read & write process and the close process.

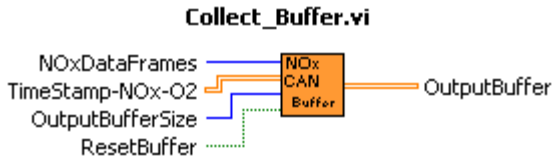
ObjHandle in The object handle for all subsequent NI-CAN VIs for the communication object that is opened during the initialization process.

Error in Passes the status, code and source of an error on through the program so that it can be output through ErrorOut.

TX- ID ID of the CAN message that was broadcast to the Sensor Control Module. This value is passed within this cluster so that the close VI can shut down the Sensor Control Module so that the sensor isn't accidentally left on.

ErrorOut Standard LabVIEW error cluster output from all VIs involved in the CAN network interface

Collect_Buffer.vi
This VI collects data output from the read and write VI and places it into a streaming buffer that can be used for graphing or data acquisition purposes. It is not locked so it can be modified internally. This was done so that end users can adjust this VI as needed and understand the process going on internally.



NOxDataFrames The number of values that were overwritten in the TimeStamp-NOx-O2 array.

TimeStamp-NOx-O2 A two dimensional array having 3 columns of data in the following order: TimeStamp (seconds since January 1, 1904), NOx (ppm), and O2 (%). The array has a fixed number of 20 rows. Each call to NOx_CAN_R&W_revA.vi takes all buffered CAN messages from the CAN device since the last call and filters out every message except for the NOx sensor module messages identified by the specified RxID. These new messages overwrite the TimeStamp-NOx-O2 array from the top. NOxDataFrames identifies the number of new data points received into the array.

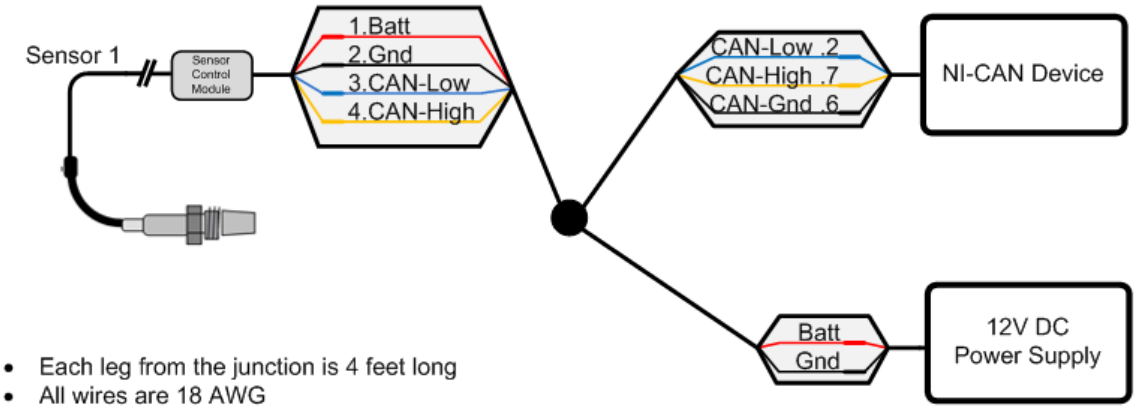
OutputBufferSize The number of elements that are held within the OutputBuffer.

ResetBuffer Resets the buffer and fills the entire buffer with the latest value.

OutputBuffer A streaming buffer of the latest number of data points that have come off the CAN bus. The size of this buffer is defined by the output buffer size. This is a two dimensional array that is in the same format at the TimeStamp-NOx-O2 array.

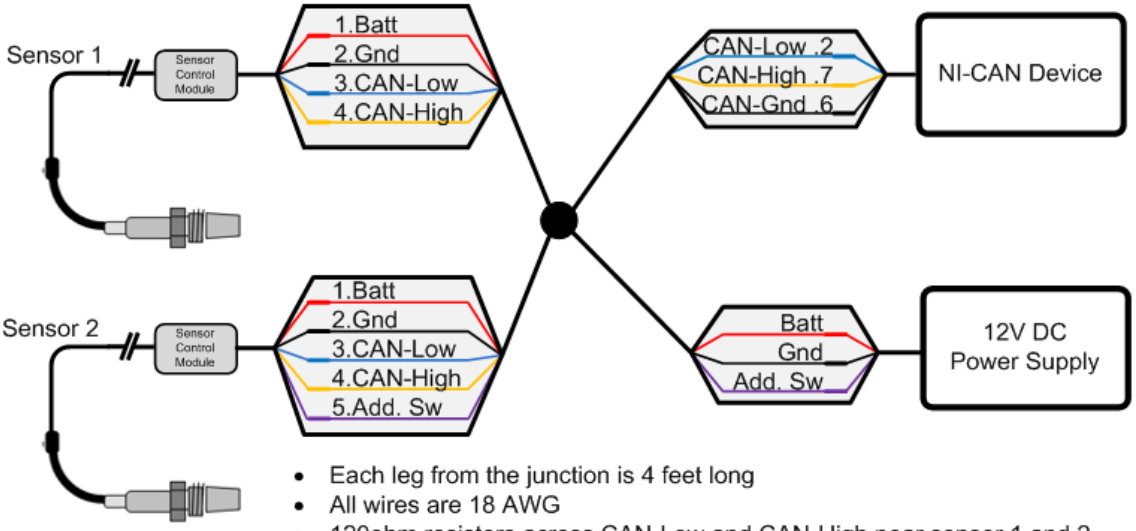
Wiring Harness Documentation

1-Sensor Harness



- Each leg from the junction is 4 feet long
- All wires are 18 AWG
- 120ohm resistors across CAN-Low and CAN-High near the sensor
- NI-CAN devices connect to the harness through a female DB-9 connector.
- CAN-Ground is connected to Ground near junction.

2-Sensor Harness



- Each leg from the junction is 4 feet long
- All wires are 18 AWG
- 120ohm resistors across CAN-Low and CAN-High near sensor 1 and 2
- NI-CAN devices connect to the harness through a female DB-9 connector.
- CAN-Ground is connected to Ground near junction.
- Add. Sw should be connected to ground at the power supply